DOCUMENT RESUME

ED 289 082 CE 049 321

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TITLE Systems Analysis.
INSTITUTION Goodwill Industries of America, Inc., Washington, D.C.; Wisconsin Univ.-Stout, Menomonie. Stout Vocational Rehabilitation Inst.
SPONS AGENCY Rehabilitation Services Administration (ED), Washington, DC.
REPORT NO ISBN-0-916671-69-0
PUB DATE 87
NOTE 58p.
AVAILABLE FROM Materials Development Center, Stout Vocational Rehabilitation Institute, University of Wisconsin-Stout, Menomonie, WI 54751.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Adult Education; *Long Range Planning; Postsecondary Education; Program Administration; *Program Evaluation; *Rehabilitation Centers; *Rehabilitation Programs; Secondary Education; *Systems Analysis; Vocational Education; *Vocational Rehabilitation

ABSTRACT

This manual presents facility administrators with basic information on the analysis of systems operating in their organizations in order to provide effective long-range planning for rehabilitation programs. It provides a format for analyzing flow patterns and shows how systems analysis can be used to improve administrative decisions. Chapter 1 proposes a working definition of a facility system and examines the role of facilities within larger community systems. Chapter 2 examines the types of systems and the most likely system organization in facilities. Chapter 3 discusses system dynamics. In chapter 4 the major system processes are explained. Chapter 5 presents the analysis of systems and their processes. Finally, in chapter 6, the process of integrating a systems analysis process with facility program evaluation and long-range planning is outlined. A listing of systems analysis resources is appended. (YLB)

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SYSTEMS ANALYSIS

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SYSTEMS ANALYSIS

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ISBN: 0-916671-69-0

This publication was funded in part by a grant from the Rehabilitation Services Administration, U.S. Department of Education, Washington, D.C.

FOREWORD

Goodwill Industries of America, Inc. and the University of Wisconsin-Stout have entered into an agreement to jointly create publications that help improve service delivery in rehabilitation facilities. Manuals developed to supplement in-service training programs by the staff of Goodwill will be further developed by Materials Development Center for use by professionals in rehabilitation facilities nationwide.

Systems Analysis is based on three manuals developed by Goodwill as part of their staff training series, "Program Aid in Rehabilitation." The original manuals were titled "System Analysis-Information," "System Analysis-Terms," and "System Analysis-Flow Analysis." In this publication, these manuals have been combined, edited, and expanded to provide a manual applicable to all facilities. The use of systems analysis, explained in this manual, will help facility administrators implement and improve their service delivery.

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PREFACE

Individual rehabilitation programs within rehabilitation facilities should be viewed as integrated parts of a larger whole that is the facility. Each individual program (often called "center" or "unit") has an effect on the operation of the whole facility. Additionally, the facility as a whole affects each individual program.

Just as important as viewing the individual programs of a facility as parts of a larger and interactive whole, the facility itself must be viewed as one part of an even larger community structure. It is easy to visualize the facility in relationship to other social service agencies and funding providers, but this is only part of the community. The facility is affected by every facet of the community, including the political, economic, religious, recreational, and social aspects. Further, the facility affects these other community organizations.

Within each rehabilitation program, a pattern of client flow exists. This is the formal/informal pattern of client movement that controls the movement of people into the program, regulates their activities, and indicates when they should be moved out of the program. These patterns, like the relational patterns between facility programs, are called "systems."

An examination of these "systems" relationships, both internal and external, can provide facility administrators with data about the operation of the facility. The data gathered for and interpreted through systems analysis, may show areas where improved information or materials flow can enhance the results obtained by a rehabilitation program. A formal systems analysis procedure, developed, documented, and used regularly, can become an integral part of the facility's program evaluation process.

The Commission for the Accreditation of Rehabilitation Facilities (CARF) strengthened the tie between systems analysis and program evaluation by actions they took in developing the 1985 revision of standards for

facilities. The commission set standards that made program evaluation an initial step in facility long range planning.

As part of the facility's program evaluation process, systems analysis provides data vital to the development of long-range plans for facilities, plans that are closely tied to the marketing of facility services. The ties linking program evaluation, long range planning, and facility marketing are established by viewing facilities and facility programs as elements of larger, interdependent community structures.

To provide effective long-range planning for rehabilitation programs, facility administrators must closely examine the systems operating in their organizations. This manual presents basic information on the analysis of systems, provides a format for analyzing flow patterns, and shows how systems analysis can be used to improve administrative decisions.

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AN INTRODUCTION TO SYSTEMS

Programs within facilities are constantly transferring clients in and out to complete various phases of their rehabilitation program plans. Thus the facility is in a constant state of flux as internal and external relationships change. The daily status of the facility depends upon the interactions of each component rehabilitation program through client flow, staffing, and budgetary decisions.

This interaction closely ties the interests of each program to all other programs within the facility. Interactions, such as changes in client intake and discharge patterns, in one program may greatly influence the operating capabilities of all other programs in the facility. Additionally, the fiscal success or failure of one program influences all others.

For example, the manager of a janitorial training and contracting program was charged with providing work opportunities to mentally retarded adults. Because the program was limited to small contracting sites by the lack of specialized cleaning equipment, the manager decided to write a proposal for a state administered establishment grant. Funds from the grant would allow the manager to purchase special equipment needed to obtain larger janitorial contracts. The equipment requested included an expensive floor scrubbing machine. Grant recipients were required to "match" grant funds "one for three." Thus the facility would need to provide 25% of the money to purchase the scrubbing machine and other items if the dollars were granted. The janitorial program was very successful and additional contracts would clearly enhance both the cash flow and reputation of the facility; thus, the facility director gave the program manager permission to submit the grant proposal. It was funded.

To provide the facility's 25% contribution from an already limited budget, the facility director delayed the planned purchase of a new truck needed to transport janitorial crews and their equipment to jobs. The old truck needed to be replaced, but it was still operating.

Three months later, however, the old crew truck broke down, a total loss. Facility funds were even tighter after the replacement dollars for the truck were tied up in the purchase of the new scrubbing machine and other equipment. The operations of the crews needed to be suspended until funds could be obtained to purchase a replacement vehicle.

With crew activities curtailed, the facility's entire client flow pattern was disrupted. Clients normally referred into the janitorial training program were referred to other programs or placed on waiting lists. Some of the janitorial clients were laid-off, others were given reduced hours within the facility's production program. Because the janitorial clients were given work normally reserved for assembly workers, all production clients received reduced work loads and, thus, lowered wages.

Because no crew work was being performed, the facility lost all the revenue from its janitorial contracts. In fact, some of the businesses affected by the disruption of service cancelled their cleaning contracts and were lost as revenue providers entirely. Thus the cash flow of the facility deteriorated even further, hampering efforts to obtain a replacement truck. In just a few weeks, complications from the receipt of grant funds had started a downward spiral for the facility that may prove extremely difficult to overcome.

The irony of this example is that the problems began when the manager of one rehabilitation program tried to strengthen the facility's position by purchasing equipment that could expand the program's ability to provide training options for clients. Both the program manager and the facility director were simply doing their jobs, providing training opportunities for persons with disabilities.

The facility director failed to appreciate the possible consequences of shifting ear-marked dollars. An analysis of the janitorial contracting system would have forewarned the director of the serious consequences of vehicle failure. This does not mean that the grant should not have been submitted. Only that if the weakness had been foreseen, alternate transportation systems could have been developed to allow the program to continue to operate in the event of vehicle failure.

This is, of course, an over-dramatized example. The actual effects of daily decisions within a facility are far more subtle, but they have the potential for similarly severe consequences.

In the following chapters we will take a close look at systems and their operation within rehabilitation facilities. In chapter one a working definition of a facility system is proposed and the role of facilities within larger community systems is examined. The types of systems, and the most likely system organization in facilities is examined in chapter two. Chapter

three provides a discussion of system dynamics. In chapter four, the major system processes are explained, and in chapter five, the analysis of systems and their processes is presented. Finally, in chapter six, the process of integrating a systems analysis process with facility program evaluation and long range planning is outlined.

The use of systems analysis will give administrators a planning and evaluation tool that may help them provide more effective and efficient client services.

CHAPTER ONE
A METHOD OF EXAMINING YOUR ENVIRONMENT

Defining Systems

A system is an interactive relationship that exists between units, with the activity of one unit affecting the behavior of all other units. Units can be programs, departments, people, or things.

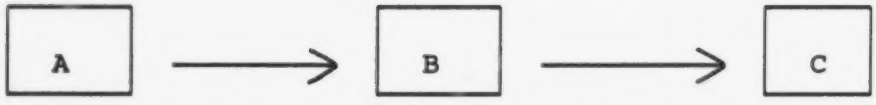
Differences are found in the grouping of large numbers of people. Large units of people can be examined by looking at the way the groupings function as systems. For example, what is the difference between a crowd and a mob? The units within each of these groupings are identical; they are people. Therefore, the differences between a crowd and a mob must be determined by observing the actions of the people within their respective grouping.

In a mob the actions of each person directly affect the actions taken by other people in the mob. To understand the actions taken by a mob, it is necessary to consider the actions of all the units and surrounding conditions such as climate, physical location, and the behavior of other people or organizations affected by the actions of the mob. Because the definition of a system states that the activity of one unit in a system directly affects the behavior of other units, a mob is a system.

In a crowd, people act as individuals. Their behavior has little effect upon the behavior of others. This type of grouping is called an "aggregate" to distinguish it from a system.

A system can be diagrammed as found in Figure One:

Figure One



A simple system in which "A" affects "B" which, in turn affects "C".

One unit affects others through client flow (numerically), actual staff performance, or through psychologically induced attitudes.

If an evaluation program serves more clients than normal, the number of clients it refers to the facility's training program is also likely to increase. Thus one unit (the evaluation program) has affected another unit (the training program) by numerical means.

If no change is experienced in the number of clients served, but new client processing procedures are instituted, we can expect the changes to affect the training program. The new procedures will probably lead to changes in performance for the evaluation staff, affecting the performance of the staff of the training program to carry out plans dictated by the evaluation results. Thus, the change in procedures has lead to a change in staff performance that is passed on to the training program staff. This change in performance may have negative effects for the training program because the training program staff will be unable to address the real needs of the clients they serve.

Further modifying the example, we assume that no change in either client flow or staff performance has occurred. However, the staff of the training program have somehow begun to believe that the staff of the evaluation program are apathetic and unconcerned about the problems that they (the training program staff) experience carrying out the plans developed from evaluation reports. This belief may, or may not, be based on fact. The beliefs, never-the-less, have an effect on the acceptance of evaluation results.

Facilities as Parts of Systems

Even large, seemingly autonomous systems are units of systems. The least complicated system in a rehabilitation setting is the relationship of a single staff member to one client. That elemental system joins others to make up a rehabilitation program, such as a training program. At this level, the system consists of the program supervisor, staff, and clients.

The rehabilitation program is one unit of a larger system, often the rehabilitation department. The rehabilitation department is one unit of a larger system called the facility. The facility is a unit of yet a larger system. That system consists of public and private schools, hospitals, public institutions (such as mental health, corrections, and chemical abuse), private psychologists, social workers, physicians, not-for-profit and for-profit rehabilitation organizations, and governmental agencies such as vocational rehabilitation, social security, JTPA and the Veterans Administration. This system is often called the state/federal rehabilitation complex.

Researchers have found that administrators vary in their concern about the effects of change in one unit of a system on other system units. This variance seems to be correlated with the size of the organization. Organizations with small market shares of their market segment tend to be concerned only with internal systems. Organizations with large market shares of their market segments are more apt to have administrators that are concerned with the behavior of other organizations that will affect their organization's market share.

Most large facilities have emerged from small, struggling rehabilitation programs. Even though they now are competitive in their communities, their evolution from small programs has left most of their administrators primarily concerned with internal systems. These facility administrators should seriously consider the effects community systems have on their operations.

Facility managers tend to limit consideration of community systems to other agencies providing similar services. Thus they may limit their examination of factors affecting referral rates to the state vocational rehabilitation agency. However, only a small percentage (about 10%) of the clients served by most state agencies receive service in rehabilitation facilities. Thus, the majority (about 90%) of the VR clients are receiving some type of alternative service. These alternative services (such as university based demonstration programs, trade schools, private therapists, counseling programs, etc.) are taking clients that may otherwise be referred to the workshop. Thus, an administrator should examine all community options open to persons with disabilities to accurately determine the direct effect community systems have on the operation of the facility.

CHAPTER TWO
TYPES OF SYSTEMS

Two types of systems can operate within an organization. They are closed systems and open systems. Of the two, only the open system is of major use for the analysis of facility operations.

Closed Systems

Closed systems have no regular input or output. Figure Two below is a diagram of a closed system.

Figure Two

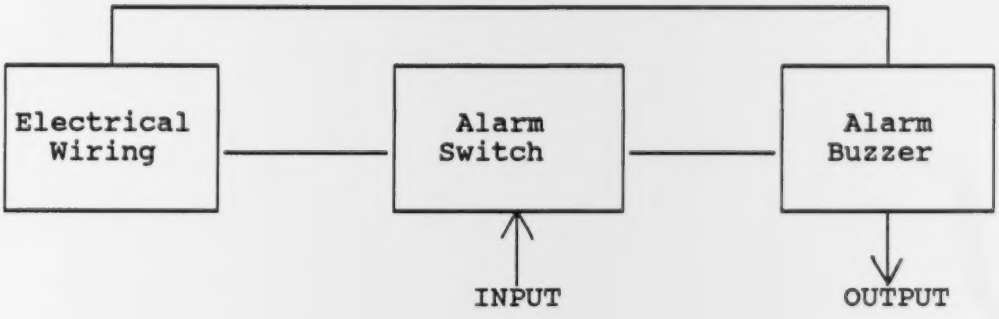


Diagram of a closed system.

Figure Two shows a fire alarm circuit operating as a closed system. Once the system's circuit is closed, the alarm rings. Because the closed

system has no other inputs or outputs, the alarm will continue to ring as long as the circuit is closed, even when no fire exists. A closed system is rarely found operating in facilities.

Open Systems

In an open system, inputs and outputs can vary in intensity and duration. For example, a pot of water on a stove can be examined as a system. Heat is applied and absorbed by the pot until the water reaches its boiling point. When the water begins to boil, the heat input is no longer used to raise the temperature of the water, it is used to convert the water to steam. Thus a change has ocurred in the system's output. If the amount of heat input is constant, the steam output will also be constant.

The system formed by the pot of water and the stove will reach a "steady state" when the heat and steam are constant, the state at which inputs and outputs do not fluctuate. In Figure Three below, an open system at work in a rehabilitation setting is presented.

Figure Three

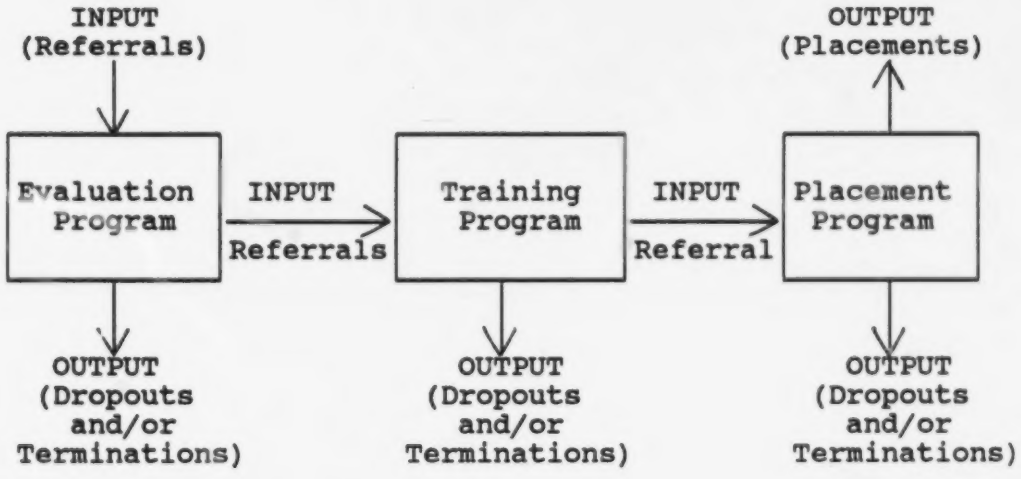


Diagram of an open system (without feedback loops.)

When a rehabilitation program is begun, it will take time before the first clients complete the training process. At the beginning, clients are either filling programs or leaving through self-termination (dropout) or discharge. Eventually, the number of clients completing the training program, plus all terminations will equal the program's client intake, and the program system will have achieved a "steady state." For example, if an evaluation program is designed to be completed in one month, a training program four months, and a placement program one month, the minimum time required for the facility system to reach a "steady state" condition is six months.

CHAPTER THREE
SYSTEM DYNAMICS

Facility systems will principally exhibit two dynamics: feedback loops and feedback delays. Both dynamics are important when analyzing facility operations.

Feedback Loops

Virtually every system requires feedback from its component units. Systems also need mechanisms (or regulators) that respond to the feedback. If no regulator is present or the regulator is not sufficiently sensitive to process feedback data, many problems may develop. An example of a system incorporating a feedback loop is shown in Figure Four below.

Figure Four

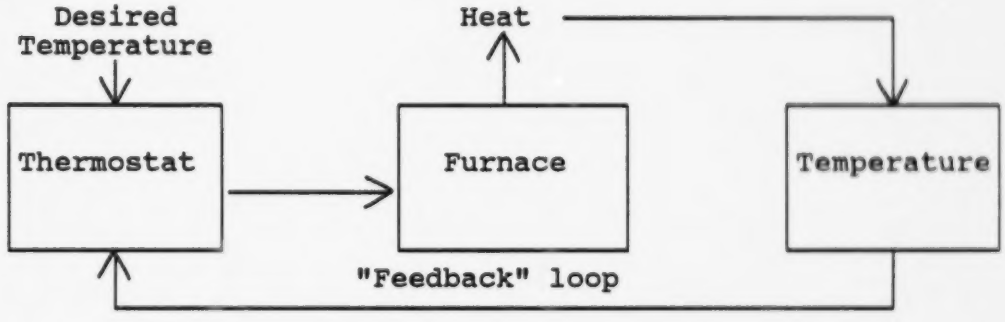


Diagram of a feedback loop.

Figure Four illustrates the use of a thermostat as a feedback device in a heating system. A thermometer on the thermostat registers the temperature in the house. The thermostat has been programmed to trigger the furnace control when the temperature (as registered on the thermostat) drops below a preset level thereby providing "feedback" to the furnace, acting as a feedback mechanism. Turning on the furnace raises the level of heat in the house. As the temperature rises, the thermometer on the thermostat also rises and, when the temperature reaches a predetermined desired temperature, it triggers a switch that turns off the furnace, again providing feedback.

If the thermostat did not provide feedback to the furnace, the furnace would need to run continuously or intermittently to heat the house. It could not provide a uniformly comfortable temperature for the house. A similar situation exists for the provision of human service programs as illustrated in Figure Five below.

Program evaluation provides feedback to rehabilitation programs like a thermometer provides feedback to a heating system. Without program evaluation there is no way to determine if the program is producing the desired results. Programs without evaluation feedback continuously provide the same training curriculum or make occasional, arbitrary changes.

Figure Five

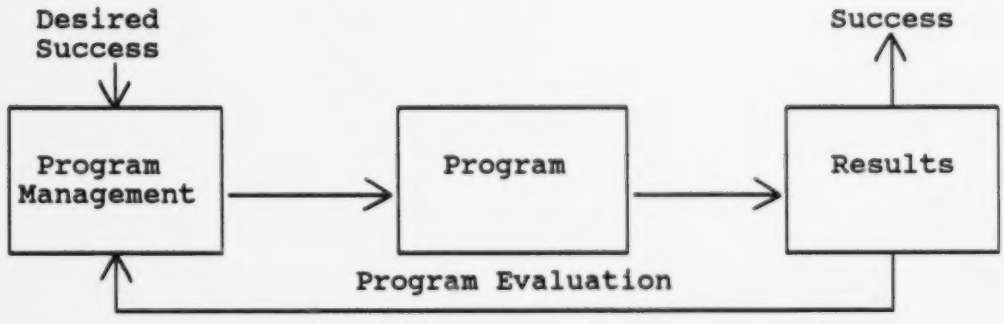


Diagram of a feedback loop in a rehabilitation system.

In Figure Five, "desired success" is a system input that enters at the same "port" as "desired temperature" in Figure Four. Because "desired success" is sometimes thought of as the highest performance level attainable, this location within the feedback loop may be confusing. Because

program success can be enhanced artificially by methods such as careful selection (creaming) of clients, the highest performance level attainable should not be considered the "desired" success rate for the program. Thus, "desired success" is not the minimally acceptable performance level for a program, it is that level of success that provides the optimum service provision to clients served by the program. Thus, the feedback in rehabilitation systems is not as mechanical as in heating systems.

Feedback Delay

Time is required for feedback data to be transmitted to and confirmed by the action generating parts of the system. This time is called "feedback delay." For example, within the system of "higher education" the prestige of a university is gauged by the accomplishments of its graduates. Because at least five years must pass following graduation for most graduates to be noted as major contributors to their chosen fields, the present reputation of the university is really based on the actions of the university five years earlier. Rehabilitation programs are also judged by "old" data, though the "old" data has been delayed only about two to five months.

Some facility decisions need to be made before feedback data is available. For example, a student may choose to enter a university degree program because existing data shows promising future openings for graduates of that curriculum line. Unfortunately, that data on employment, even if not subject to collection delays, will not be relevant for the job market four years later when the student graduates.

Feedback delay is unavoidable. It exists in every system loop. However, the length of the delay should be kept as short as possible, for control of the system becomes more difficult as feedback delays lengthen.

Facility administrators can take measures to lessen the impact of feedback delays. Intermediate measures of performance can be determined to lessen the impact of the data delay. These measures will not replace long term data, they will supplement those measures. Additionally, administrators must pay close attention to forecasting techniques. Decisions that must be made before feedback is available must be based on intelligently gathered data, using sound statistical bases. This is particularly true when determining employment patterns.

CHAPTER FOUR
SYSTEM PROCESSES

Systems analysts look for the presence and dynamics of several processes that may, or may not, be at work in a facility system. All of these processes may be present in your facility programs; they can work together or individually. They are:

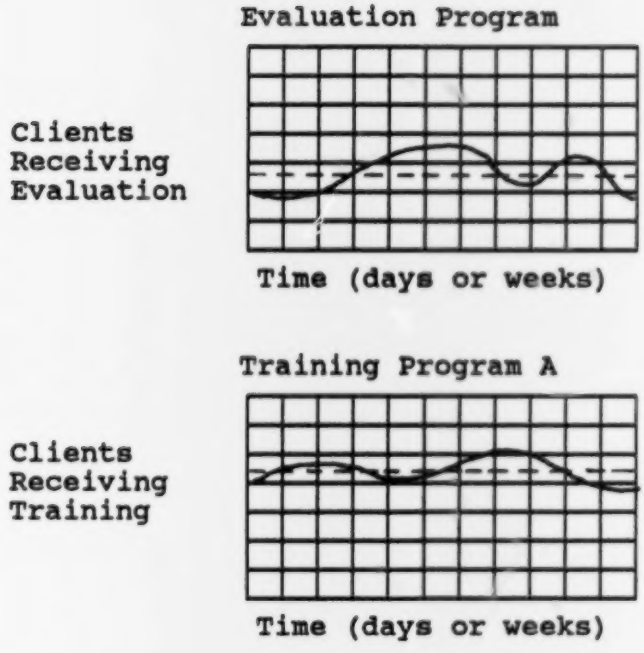
1. Oscillation
2. Routing
3. The reservoir effect
4. Trajectory
5. Equifinality
6. Valves
7. Trigger variables

Oscillation

"Oscillation" is the pattern of variation in system input and output. Input and output volumes fluctuate. Sometimes they are relatively large, and at other times they are relatively small. If these variations (oscillations) decrease with time, the oscillation pattern for the system is called "dampened." Figure Six, on the following page, illustrates oscillation and the dampening pattern.

Evaluation programs almost always have more input/output oscillation than training programs. Evaluation programs oscillate because of their dependence on external referral sources for their clients and because they have clear definitions of program completion.

Figure Six



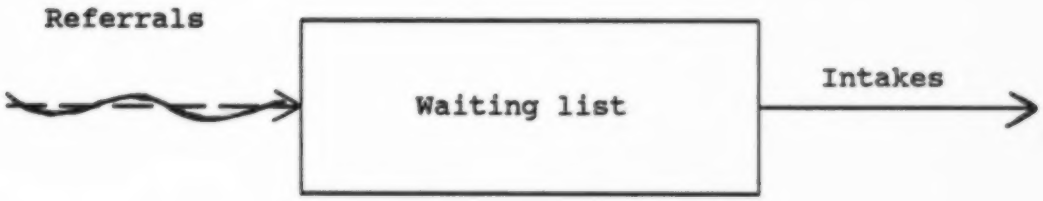
An illustration of oscillation in client counts in typical evaluation and vocational training programs. (The dotted horizontal line represents the average census.)

Training programs are less likely to exhibit major input/output oscillations. If the average client remains in a training program from three to six months, a short term (two week) decline in referrals will have little effect on the total number of clients in the program.

The training program is also likely to receive the majority of its referrals from facility (internal) sources. Programs that do not rely on external referrals are less likely to be affected by client flow oscillations. Final work readiness or placement preparation programs are, thus, less likely than other programs to have major swings in client loads.

One tactic used to dampen client flow oscillations is the creation of a client waiting list. Figure Seven, on the following page, illustrates the effect of such a waiting list.

Figure Seven



An illustration of the effect a waiting list has on referrals. It dampens load oscillations. (The dotted line represents the average number of referrals.)

Waiting lists should be long enough to eliminate referral oscillations. However, because long waiting lists increase dropout rates, the length of the list is affected by the facility's need to minimize dampening and its desire to minimize dropouts.

Oscillations occur for five reasons:

1. Seasonal variations
2. Feedback delays
3. Insensitive control devices
4. Long response times
5. Overreactions to feedback information

Seasonal variations

Some rehabilitation programs are subject to seasonal variations in their client loads. Variations in funding periods, staff and client vacation schedules, and seasonal changes in weather conditions can cause client count oscillations. The client referral source or funding agency may also have seasonal factors (such as fiscal periods) that will affect the program's client count.

Feedback delays

Oscillations can also be caused by feedback delay. For example, training programs that prepare clients for high demand occupations will experience high demand until the need for workers in these occupations is met. However, the demand for training in these occupations is likely to continue even after the need for workers has been filled. Thus more workers will be trained in the area than are actually needed by the field.

As trained workers fail to obtain jobs, it will soon become known that an overabundance exists for workers in the area. The demand for training will, then decline rapidly. The oscillation cycle will continue as lessened demand for training creates a trained worker shortage, etc. ad infinitum.

Insensitive control devices

A third reason oscillation occurs is poor sensitivity of control devices. For instance, our bodies are far less sensitive to temperature changes than are thermostats. People who stoke wood furnaces know that the temperatures within their homes vary widely. This is true because the furnace is stoked when their owners perceive the need for more heat; when they stoke their furnaces, they put in enough wood to lengthen the time until the next stoking, thus insuring that the temperature rises. Compared with temperature variations in homes equipped with thermostatically controlled furnaces, the wood heated home has a great range of temperatures.

Insensitive control systems are also responsible for wide variations within facilities. Sensitively controlled rehabilitation programs usually have targeted referral rates. When referrals fall below this targeted level, the program administrators begin to actively solicit referrals. Waiting until the client referral rate is low enough to cause concern before attempting to increase the rate is certain to increase the range of client flow oscillations within the facility.

Long response times

System oscillations often accompany long response times. In a heating system, for example, the thermostat must be set to activate the furnace before the room temperature actually falls to a desired degree setting. This allows the furnace to respond to a new heat demand even as the temperature in the house continues to fall. The thermostat also should be set to trigger the furnace to stop producing heat before the optimum temperature has been reached, allowing the heat remaining in the furnace to deliver its final heat energy without overheating the house.

In training programs with exit criteria established as attainment of a certain level of quantity or quality of production, a response time gap exists between the time that the criteria level is reached and the time that it is recognized. Thus, as a client narrows the gap between the exit criteria and current skill levels, the frequency of measurement usually increases.

Overreaction to feedback information

The final reason that oscillation occurs is the tendency to overreact to feedback information. For example, when taking a shower it is natural

to turn on both hot and cold faucets. Because the water from the "hot" faucet has been in the pipes for a while it comes out cold. To quickly discharge this cold water, it is natural to turn the "hot" faucet to full volume. When the hot water finally arrives, it is scalding, prompting the bather to quickly reduce the flow. Often, the flow is slowed too much and must be adjusted again. After several oscillations between extremely hot and extremely cold a balance is struck. Responding to feedback oscillation in this manner is called "control by successive approximations."

Control by successive approximation works well unless the system administrator cannot recognize underlying principles. For example, the bather through experience or training could reduce oscillations by noting that the hot water must be given a chance to reach the shower head before the shower temperature is fine tuned.

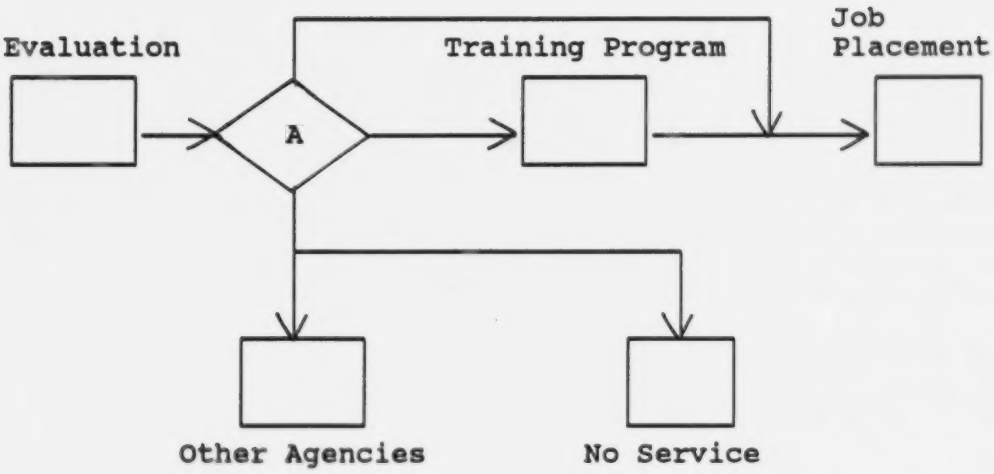
The administrators of training programs often attempt to dampen the oscillations due to overreaction to feedback by creating policies (for entrance or exit) that require a sustained level of feedback. For example, the exit criteria from an industrial housekeeping program is likely to include elements of skill, quantity and quality, and a sustained effort at that skill level. Thus, the criteria may be stated: Evidence 90% productivity (based on the program's 90/10 productivity evaluation) for three evaluation periods.

Routing

In a systems context, routing refers to the establishment of review points. When a review point is reached, the program administrator decides which one of several routes the client, data, or materials will follow. Review points, routes, and routing rules may be in the form of documented policies or based on experiential judgments. An example of a routing path is shown in Figure Eight on the next page.

Though review point "A" is individually determined, decisions tend to develop consistent patterns over time. An examination of routing decisions made at the end of an evaluation program, will probably show that consistent percentages of clients are referred to the various work adjustment and placement programs available in the facility and community. These routing percentages are one of the most important tools of systems analysis. The analysis of system behaviors depends on the analysis of routing patterns as well as intake and discharge rules.

Figure Eight



An illustration of a "routing" point (A) as part of a facility system.

Reservoir effect

Reservoirs perform essentially the same function in human service delivery systems as in water delivery systems: they dampen input oscillations. They are called "waiting lists" when an attempt is made to quantify the units in the reservoir by listing each person eligible to enter the program.

Water reservoirs lose holding units through evaporation. Human service delivery system reservoirs (waiting lists) also lose "units" over time. Potential clients remove themselves from the reservoir as their time on the list is extended. They are lost to other training opportunities and to disinterest.

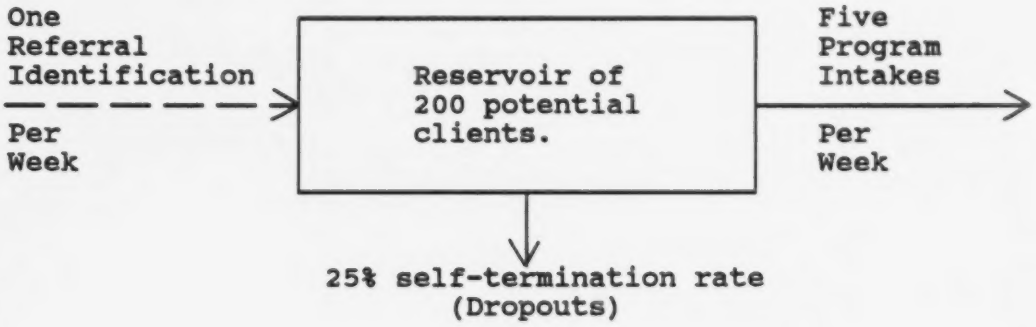
Predicting the exact size of a reservoir is difficult. For example, the local vocational rehabilitation agency may have 200 clients on their roles that have indicated a desire to receive janitorial training. Based on this data, the facility administrator develops a training curriculum and intake/-discharge procedures designed to accept five clients per week in janitorial training. Because some oscillation in output is expected, the program was created with the expectation of a one year term of operation. A program

manager and staff were hired and equipment purchases made on the strength of the reservoir predictions. After eight weeks, referrals dropped off dramatically. Conferring with the state agency, the program manager discovers that the program has fallen victim to the "reservoir effect." This effect is illustrated in Figure Nine below.

The state agency's list was accumulated for four years at the rate of one client per week. Because the list was "aged," only a small percentage of the clients could even be contacted at their listed addresses. (Conservatively, an estimate of 75% recontact would not be unusual.) Thus the computations made for reservoir reduction must be modified.

First, client input to the reservoir must be subtracted from the expected client output (referrals to the new program.) For example, the reservoir will be depleted at the rate of four clients per week because five clients are referred to the new program while one client is added to the list. (5-1=4)

Figure Nine



An illustration of the reservoir effect. This reservoir has a one client per week input and a five client per week output. With a 25% dropout rate, the reservoir will be depleted in 38 weeks.

Second, the number of clients actually in the reservoir must be determined. If 25% of the clients cannot be located, the true reservoir actually contains 150 potential referrals. (Two-hundred multiplied by 75% equals 150.) Note that this figure is referred to as "potential" referrals. This

figure is only an approximation of those clients that can be contacted and may be willing to participate in the new training program.

Third, the 150 potential referrals are depleted at the rate of four per week. This is determined by subtracting inputs from outputs. (See step one: 5-1=4.) Thus, dividing 150 by 4 produces the result 37 1/2, the number of weeks it will take to fully deplete the reservoir of potential referrals. When the reservoir is depleted, the only possible referral is the one client per week identified by the state agency.

Of course, depletion figures such as above are difficult to obtain from a referral source. However, it is essential that the numbers are sought and, if unavailable, estimated.

Trajectory

The trajectory of a system is the apparent direction of movement for the system's units. According to Newton's first law of dynamics, a body in motion continues to move in the same direction with the same speed, unless an outside force acts upon it. The facility's system also tends to demonstrate this dynamic principle. When a program is initiated, the clients receiving training, evaluation, or placement services could be seen to be "put in motion" within the system. They are likely to stay in motion, in the direction projected, unless an effort is made to change client flow direction.

Program staff tend to continue their programs with relatively little change. This does help keep the facility system stable. However, when changes need to be made, some resistance should be expected.

Another important facility system trajectory is the perceived trajectory as observed by persons that interact with the facility: the general public, potential customers, potential clients, and potential referral sources. This "image" of the program must be considered whenever programmatic changes are made.

Equifinality

If two systems, started with differing trajectories and affected by differing environments, produce similar results, they have been affected by equifinality. For example, program "A" initially serves mentally retarded clients in a vocationally oriented contracting program. Program "B" opens its doors to serve mentally ill clients using a socialization program. Over time, the contracting program adds socialization activities and the socializa-

tion program adds contracted work activities to supplement their respective core programs. Gradually, the two programs begin to look quite similar.

Equifinality tends to occur in the rehabilitation field for four reasons:

1. People are basically the same regardless of their extant disabling condition. With few exceptions, they all need the same services and have similar goals.

2. Occupational environments have more similarities than differences.

3. The primary funding source for all programs is federal. Therefore, the programs will have a comparability consistent with similar regulations and objectives.

4. Staff with similar professional backgrounds are likely to work in all the programs, influencing the outcome in similar ways.

These tendencies toward equifinality, although they result in organizations with duplicated services, also result in better programming. Essentially, each facility explores a variety of treatment methods, finally determining those methods that best suit their programs and clients.

Valves

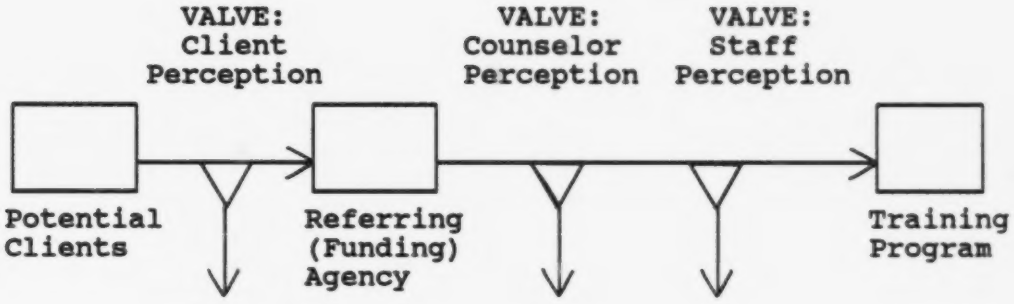
A valve controls unit flow through a system. In facility systems, valves regulate the movement of clients. They may be located anywhere within the system.

Some valves restrict the numbers of clients. For example, a program intake valve might restrict the number of clients that are admitted to the program through the use of policy statements. Policy statements could restrict client capacity by simply stating how many clients can be served at any one time.

Policies regarding program entrance also act as values, restricting numbers by creating a screening device. For example, a pre-entrance staffing to screen appropriate clients is a system valve device because the staffing committee modifies the flow of clients into the program.

Valves also operate before clients are referred to programs. They affect the client flow as illustrated in Figure Ten on the following page:

Figure Ten



An illustration of "valves" that restrict and filter potential clients for a training program.

Clients must pass through three valves before entering a rehabilitation program. They are: self-screening, counselor screening, and pre-entrance program screening.

The client's own perception is the first valve. Some people will deny the nature and extent of their disability, even to the point of refusing to apply for services from referral sources.

The second valve is individual counselor perceptions of both the client and the facility. All counselors form opinions of the facilities they encounter while providing client services. Regardless of the accuracy of their perceptions, their views will influence the number and type of clients they refer to the facility. Referrals may not be made because counselors consider their clients as too "high functioning" for placement in a program, or the counselors may consider their clients to be too disabled to enter a program.

Counselor perceptions are influenced by a number of factors. Some of these factors are:

1. The regional image of the rehabilitation program as presented in the media.

2. Their own personal experiences with the rehabilitation facility.

3. The success rate of the rehabilitation program with the counselor's clients.

4. The formal (or informal) screening practices of the rehabilitation program.

5. The number of alternative programs available to the client.

The effect of the counselor valve, often based on opinion, is to stereotype the facility. When the facility administrators plan to introduce a new program, they should send information about the change or addition to the appropriate referring counselors. It is important that the first cases referred to the new program be successful. An early client failure could negatively influence referring counselors jeopardizing future referrals.

The third valve that may limit client entrance is the facility's pre-entrance screening based on previously determined entrance criteria. Entrance pre-requisites may be based upon national, state, or local data or subjective staff opinions. For example, data derived from program evaluation has indicated that the facility success rate with mentally ill clients is poor. This may result in special attention to screening for this disability group. Thus, the pre-entrance screening may include questions designed to determine if the client has been diagnosed as mentally ill. Because entrance screenings will eliminate some potential clients from receiving services, administrators should be careful to construct the criteria using factual data.

Four other valves may also be present in the facility system. They are: Service naivete, regulation, accessability, financial constraint.

Even after a facility conducts a massive public information campaign designed to inform the general population about a facility's services, some people will not know that the facility even exists. Social science researchers have identified a sub-group of people in all communities that they call the "hard core uninformed." Because it is not likely that a massive community public information campaign has been or will be conducted, and because most government VR and social service agencies maintain a deliberately low profile, it is even more likely that the general public in your community does not know about your services. This is the valve of "service naivete." It is a valve because eligible referrals will not initiate entrance procedures because they do not know that services are available.

Nearly every funding program is regulated. They must act according to either legislated mandates or mandates that have been written into incorporation papers. Usually these regulations are in the form of identification of a narrowly defined "service population." Some criterion used to

limit funding entrance include: economic, geographic, age, and handicapping condition. These criterions are necessary to insure that referral dollars are actually spent on persons needing services.

Incredibly, some virtually inaccessible buildings still house the offices of referral programs. And even though most of these inaccessibility problems have been eliminated, some programs, by nature, may also be inaccessible. Circumstances such as the distance a potential client lives from the proper service or having dependents at home, may cause a program to be effectively inaccessible even with physical modifications in place. Additionally, even some facets of individual programs may be inaccessible.

The final valve is the valve of financial limitation. Even otherwise qualified clients sometimes must be refused service because all funds were spent before client needs were met. Strategies may even be in effect to limit the overall pool of potential clients when it is known that there will not be sufficient funding for the entire field.

Trigger variable

Trigger variables are complex factors that may exist even though not designed to be part of the facility system. They may have a profound effect on the operation of the facility because of their tendency to magnify impact with only slight increases or decreases in their actual intensity. For example, a country's birth rate is a trigger variable affecting a multitude of services and systems. Even a very small (.1 of one percent) increase in the birth rate creates enormous pressures on social service and educational programs.

Within the facility system, a "no-show" rate may be a trigger variable. If "no-shows" are only slightly increased or decreased, the program will be impacted by changes in out-placement and potential intakes.

CHAPTER FIVE
REPRESENTATIONS OF SYSTEMS

Systems analysis involves the definition, depiction, and examination of the relationships between units. Thus the methods of systems analysis involve the defining of system flow, the diagramming of system flow, and the manipulation of the flow using system models. In each of these areas, systems may be represented in many ways. The representational method used is determined by the data available, the resources to be expended, and the results desired.

Defining system flow

System flow is the movement of people or things through the organization following defined routes. Flow can be described numerically using actual unit counts, percentages of total units, or by trajectory. For example, movement of clients from evaluation into a vocational program can be stated as "Four clients per month," "Twenty-two percent of all referrals out of evaluation," or "Four referrals, vocational route." The method used is determined by the type of relationship that exists between system units, and the administrator's need for data.

Diagramming system flow

Often, numerical or trajectory definitions can be better conveyed through the use of a chart or graph. Visual representations of the quantitative and directional data will assist administrators and analysts in spotting areas of concern.

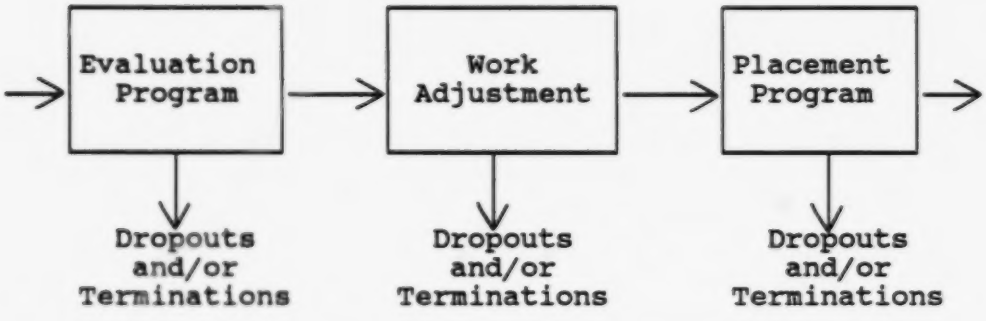
Four types of visual representations are regularly used to analyze systems. They are: activity charts, layout charts, personal relationship charts, and data charts. In this publication, the visual representations that will be used to explain the analysis of system flow will be activity charts

as they most easily convey information that is commonly used to describe systems in facilities. However, the analysis of a system should not be confined to the use of activity charts. Valuable data may be obtained from the use of other system representation to help explain the flow seen in activity charts.

Activity charts

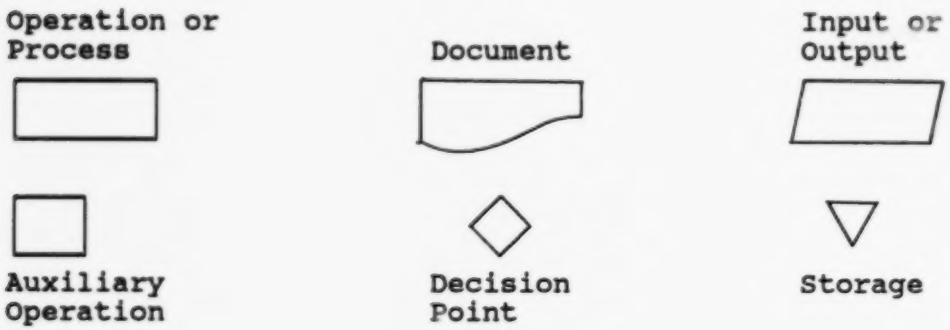
An activity chart depicts the flow of people and things through processing centers. In fact, activity charts are sometimes called process charts. They are often used to analyze production operations. Each major part of the chart indicates an area where units are changed in some manner. Figure Eleven below is an activity chart because the processes at each division act to change the units that flow through the area.

Figure Eleven



An illustration of an activity chart.

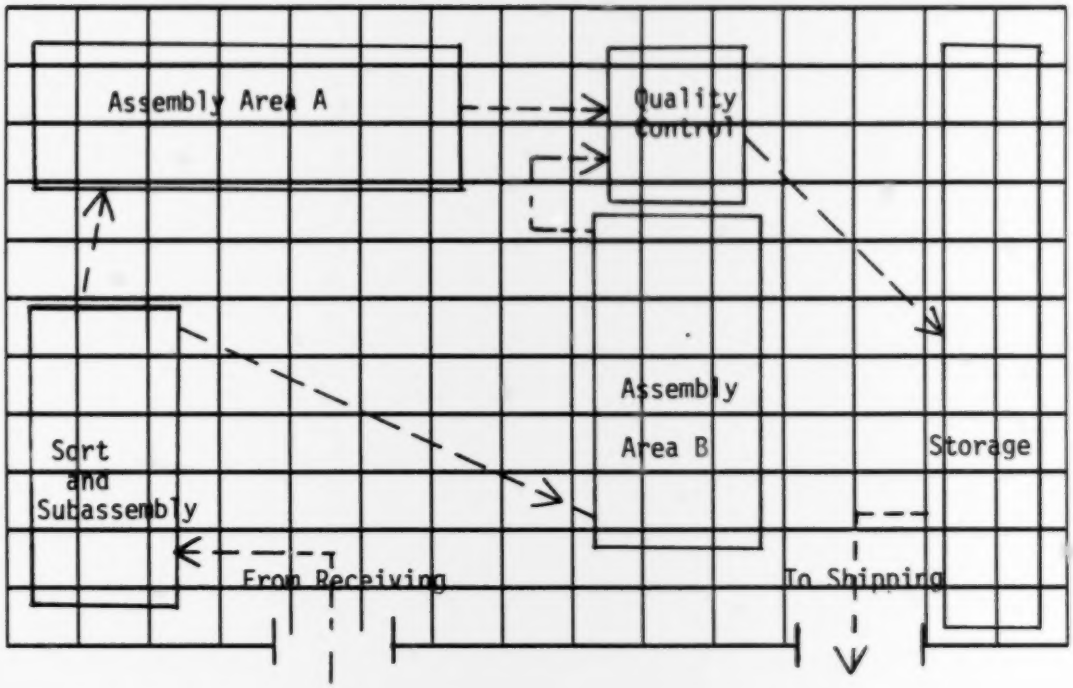
Activity charts can be used to compare systems when similar symbols are used to denote activities at each system unit. The most common system flow symbols and their meanings are listed below:



Layout charts

Layout charts illustrate the actual physical locations of processing units within a facility area and the flow that occurs between the units. They differ from activity charts only in the fact that they represent actual physical locations rather than abstract "unit" concepts. Actually, layout charts also incorporate elements of the activity chart because system flow is illustrated. Figure Twelve on the next page depicts a layout chart:

Figure Twelve

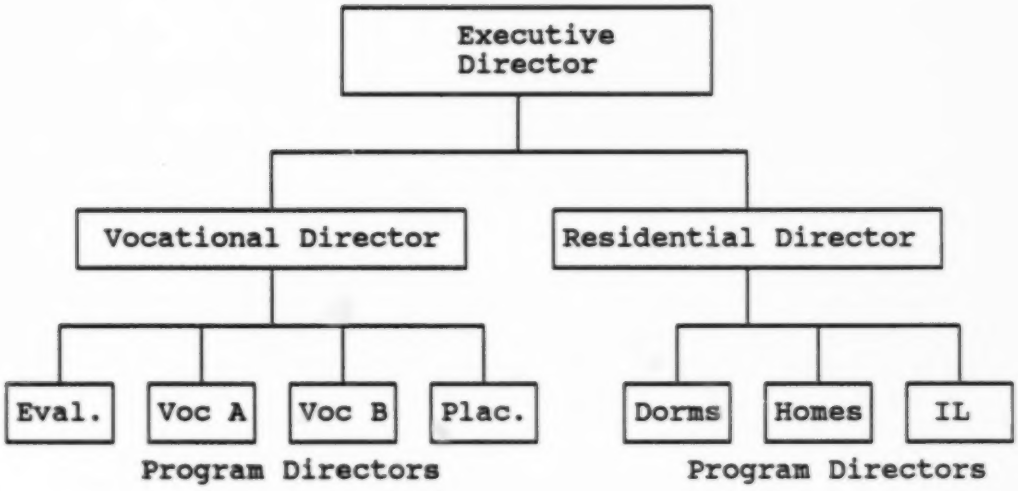


An illustration of a layout chart of a vocational program training area. Note that elements of the activity chart are also included in this illustration.

Personal relationship charts

These charts illustrate the relationships that exist between the decision making parts of the facility system. They may depict the facility's organizational structure, or indicate who is responsible for making routing decisions. The flow lines that are depicted usually represent lines of authority and indicate the persons responsible for carrying out system defined tasks. The next figure (Figure Thirteen) gives an example of a personal relationship chart:

Figure Thirteen

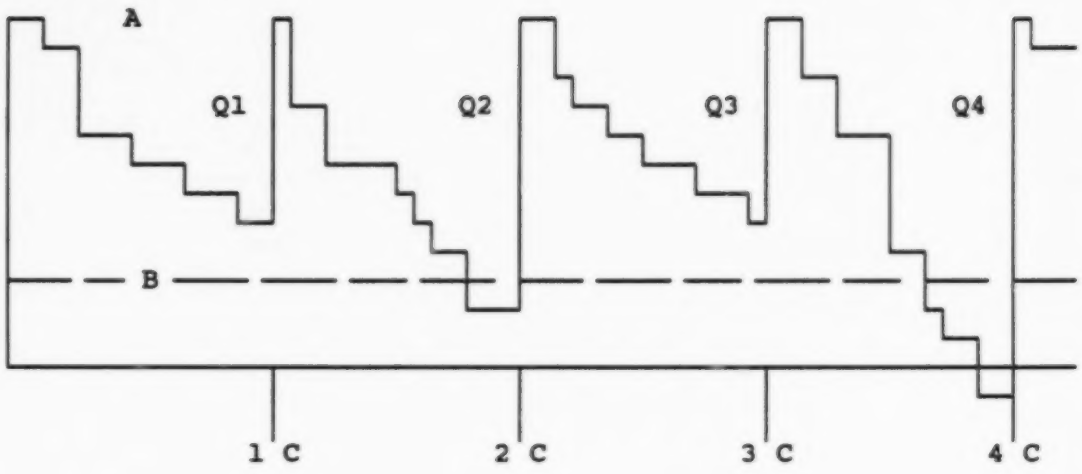


An illustration of a personal relationship chart. This chart takes the form of an organizational chart.

Data charts

Data charts give visual representation to numerical information. Data charts can take many forms. They may be bar graphs, line drawings of many types, or simply graphic displays of data. Pie graphs are not normally used to depict systems data because flow data is not easy to represent using this form. The important elements of data charting for flow analysis purposes are: equality of representation units and the use of time as an independent variable. Figure Fourteen on the next page illustrates data flow through an inventory control system:

Figure Fourteen



A = Reorder level
B = Safety stock level
C = Reorder points
Q = Order quantity

An illustration of a data chart used to describe the flow of materials through an inventory system.

Modeling

Modeling is the process of creating and manipulating a hypothetical system. Usually, modeling involves the use of one or more of the charts illustrated above. Modeling is most helpful for the following applications:

1. Identifying trigger variables
2. Understanding relationships between various parts of a system
3. Choosing among various possible courses of action
4. Predicting the effect of various uncontrollable events

Modeling a complex system with numerous feedback loops may require the use of data processing equipment (computers.) The analysis of client flow using simple models such as activity charts will serve the needs of typical vocational rehabilitation facilities. Flow analysis is a relatively simple process requiring only knowledge of basic arithmetic. Using flow analysis, administrators may create and examine system models, gathering data useful for making administrative decisions.

CHAPTER SIX
THE ANALYSIS OF A SYSTEM

The model of a typical vocational rehabilitation system is illustrated using an activity chart in Figure 15 on the following page. Facility administrators may use such a chart, with accompanying data entries, to analyze the client flow through their facility.

Analyzing system data

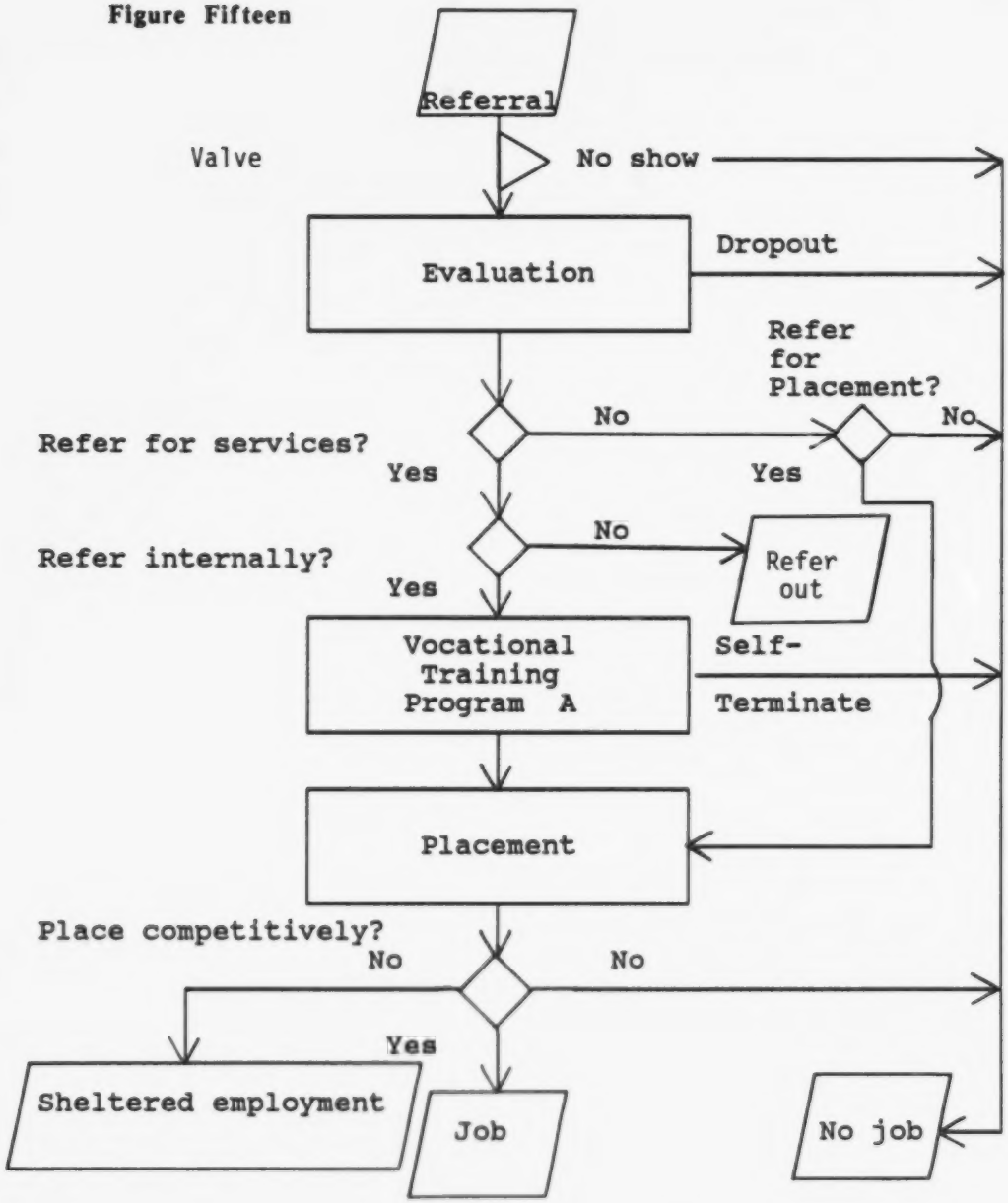
The data needed to complete a systems flow analysis include the following:

1. Intake rates
2. Routing rules and rates
3. Exit ports and rates
4. Program tenure rates
5. Capacities
6. Waiting list figures

Intake rates

Intake rates should be reported both as the number of clients per program and the number of clients per point of entry. The figures are usually reported as average weekly or monthly figures. If oscillation of the intake figures is great, notations of the oscillation ranges will help the analysts round out their picture of the system.

Figure Fifteen



An illustration of a typical rehabilitation program. Note that the flow patterns illustrate not only how clients move through the program but also how they enter and exit.

Routing rules and rates

Routing rules and rates should also be described for the analyst. The possible pathways that clients may take in their travel through the program should be illustrated, including documentation of rules that dictate movement through various routes. The program modeled in Figure Fifteen illustrates client movement routes from evaluation into placement. It also illustrates that movement from placement to evaluation is restricted. The percentage of total client flow moving through each branch of the route should be determined.

Exit ports and rates

Exit ports can be described as the means by which clients leave the system. Many ports may be described, such as: job placement, sheltered employment, self-termination, referrals, dismissal for cause, etc. The actual number of clients using an exit port and a percentage breakdown should also be determined. When examining exit data, the analyst will look for percentages that are constant over time or oscillations that cannot be explained by changes in client population or in the program composition.

Program tenure rates

Program length may be defined as a specific time period or an average of indefinite time periods. For example, some evaluation programs have set program lengths such as a standard one week program. All clients are given standard, time limited tests and complete the evaluation in exactly one week. On the other hand, some evaluation programs start with a one day assessment that is standard to all clients, but the length of the rest of the evaluation is determined by the tests assigned after the initial assessment. In the case of time specific programs, the program length is self-evident. However, in non-specific programs, especially work adjustment and skill training programs, the varying length of time that clients spend in the program requires that an average be established.

Capacities

Program capacity may be set by many factors such as: desirable staff to client ratios, space, equipment, or available work. In most cases, any of these factors can be changed, thus influencing program capacity. One reason that administrators turn to systems analysis for data is to obtain information that will allow them to make predictions of future program size and needs. System flow analysis provides data that will give the administrator time to plan.

Waiting list figures

Waiting lists are not illustrated in the facility program model above (see Figure Fifteen.) However, when the number of potential clients exceeds the flow of clients through the program, a waiting list should be established. The numbers of clients, or the lack of a waiting list, is valuable data for the systems analyst.

Examining the flow

After gathering system data and building a system model based on the data, the data and the model are analyzed to gather information helpful for determining administrative courses of action, thus improving system functioning.

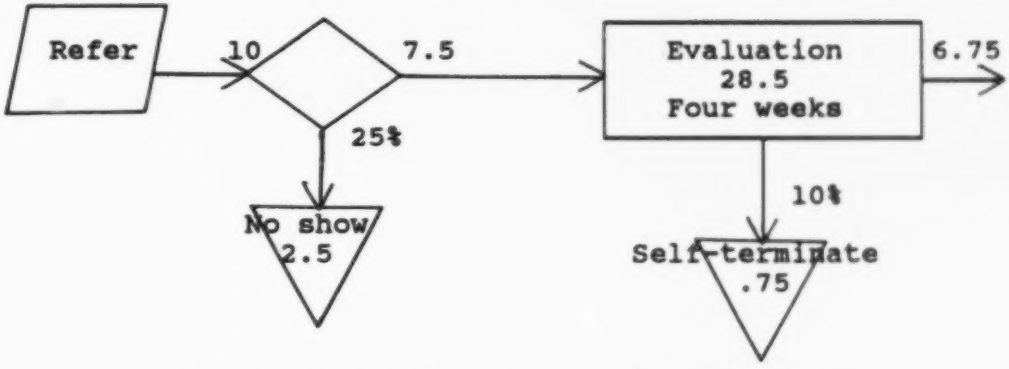
We will use the model in Figure Fifteen to show the step-by-step process of flow analysis.

Data collected regarding the flow of clients through the facility indicate that: [A] Ten persons are referred to the program each week. [B] Twenty-five percent (2 or 3) of the referred persons do not report to the program. [C] On the average 10 percent (1) of the clients self-terminate the four week program. The resulting client flow projections are illustrated in Figure Sixteen on the next page.

To determine the number of no shows, multiply the no-show rate (25%) by the number of referrals. Thus, ten referrals times .25 equals 2.5 clients per week who do not show. The number of referrals minus the no shows equals the number of clients who start evaluation each week. In this case it is 7.5. The dropouts from the evaluation program must be computed before the number of clients in a program can be estimated. In this example, 10% drop out per week. Thus, multiplying the number of clients entering the program (7.5) with the dropout rate (10%) results in the figure .75. Subtracting .75 (the dropout average) from 7.5 (the average number of clients actually entering the program each week) results in 6.75 (the number of clients actually flowing through the entire four week program.

To estimate the average number of clients in the program at any one time, we must determine the average point in the program that dropouts occur. In this example we will estimate that the average dropout occurs after two weeks of programming, or at the 50% point in the program. We must also take into account the four weeks it will take to bring the program to full capacity when it is initiated.

Figure Sixteen



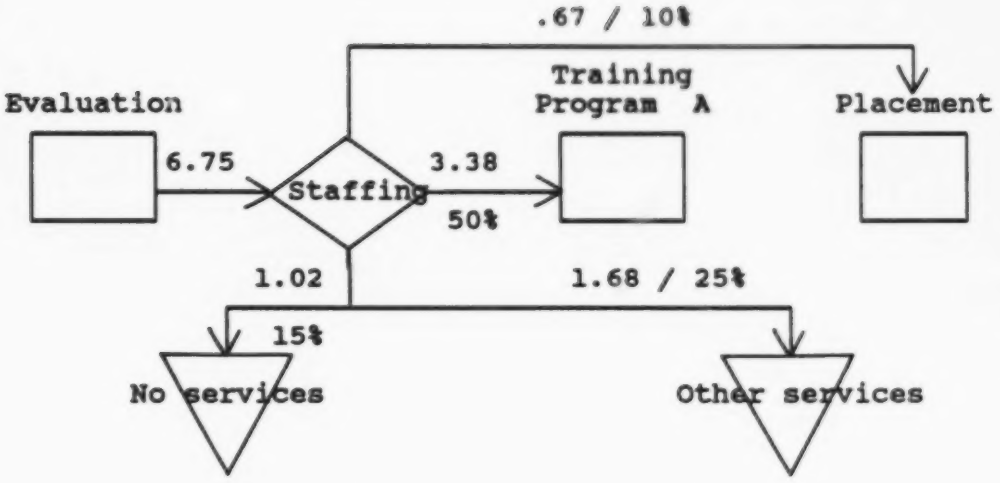
This illustration details the evaluation program. Ten clients per week are referred and 6.75 clients per week are placed in competitive jobs.

If dropout occurs at the end of the first two weeks, we can assume that 7.5 clients per week occupy the program for the first two weeks, and 6.75 clients per week occupy the second two weeks. Multiplying the numbers for each week we determine a grand total of clients per week. Two times 7.5 equals 15 and 2 times 6.75 equal 13.5. Fifteen plus 13.5 equals 28.5 or the number of clients in the program at any one time after steady state has been achieved.

Staffing decisions made at the end of the program are illustrated in Figure Seventeen on the following page.

In our example below of persons exiting an evaluation program, 50% are referred to training program A, ten percent directly to placement, 25% to other services, and 15% are not recommended for further services.

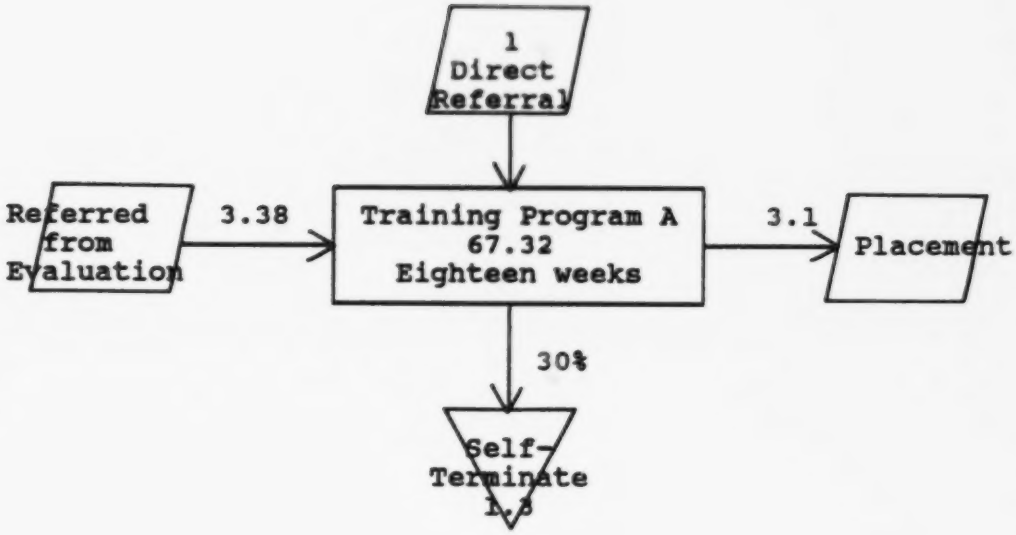
Figure Seventeen



An illustration of client flow, complete with projections and percentage figures, resulting from the routing port (client planning team staffing.)

To compute actual figures from the percentages, each percentage in the route is multiplied by the number of persons exiting the evaluation program. In other words, in this example 6.25 multiplied by .5 equals 3.38, the number of clients per week entering the training program. The numbers in Figure Seventeen show the clients achieving each outcome or proceeding into other parts of the rehabilitation system. The next illustration (Figure Eighteen) models the training program.

Figure Eighteen



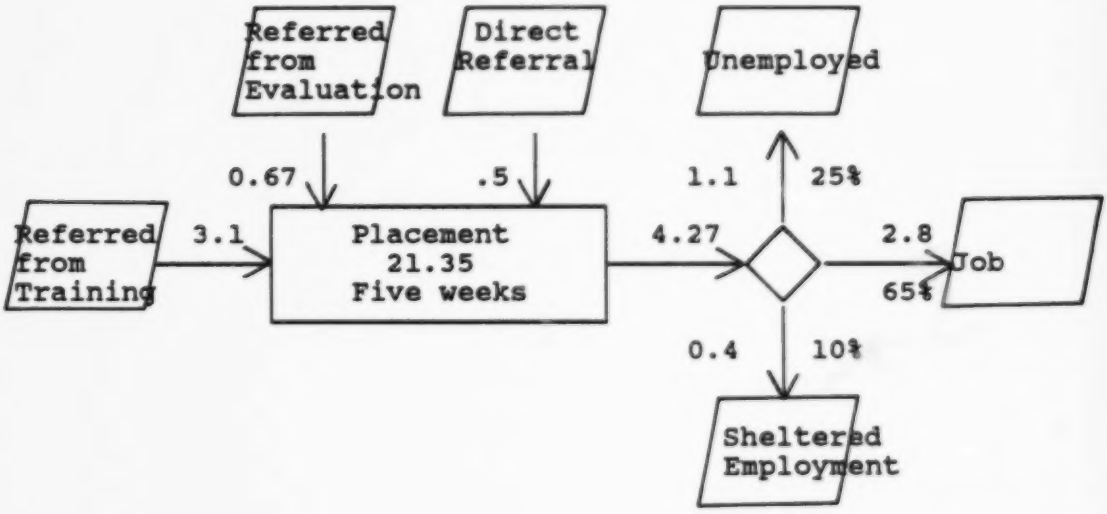
An illustration of a training program flow pattern ready for analysis.

An average of 3.38 clients per week enter the training program from the evaluation program. Approximately one person per week also enters the training program by another input port. Thus, total client movement into the training program is 4.38 clients per week. Multiplying 4.38 by a projected dropout rate of thirty percent we determine that an average of 1.3 clients will dropout per week. Subtracting 1.3 from 4.38, we determine that 3.1 clients will complete the program per week. Because the training program has an estimated length of 18 weeks and because we assume that dropouts occur half way through the program, we can determine the average number of clients in the program during any week by multiplying the first nine weeks by the total number of clients entering and the second nine weeks by the number entering less the dropouts. Thus, 4.38 multiplied by 9 results in the figure 39.42, and 3.1 multiplied by 9 results in the figure 27.1. Adding 39.42 to 27.9 results in the figure 67.32 which is the average number of clients that would be in the training program at any time after a steady state is achieved.

We now need to examine the final system component, the placement program. A model of this program is illustrated in Figure Nineteen below.

Because .67 clients per week enter the placement program through the evaluation program port, 3.1 clients per week from the training program port, and one client every two weeks, or .5 per week who enter from other ports, 4.27 clients enter the placement program each week. Because the placement program has a five week average length, the number of clients in the program each week is determined by multiplying 4.27 with 5 to obtain a figure of 21.35. In this example, 25% percent of the placement program clients do not obtain jobs. Multiplying 4.27 with .25 results in an average weekly termination of 1.1. The program figures indicate that 65% of the clients do obtain a job in competitive sites. Multiplying 4.27 with .65 results in 2.8 clients per week obtaining competitive positions. The remaining 10% (.427) of the clients are placed into sheltered employment positions.

Figure Nineteen



An illustration of a placement program, complete with the data needed to provide analysis information to facility administrators.

Uses of flow analysis information

Flow analysis is useful to facility administrators in four primary ways. First, the analysis data, usually presented in activity or numerical chart forms, provides a "picture" of the facility's present operating status. Second, the "picture" of the present system can be used to predict changes that need to be made to keep the facility healthy (effective.) Third, the system "picture" will help the administrator "balance" system units to keep them operating with peak efficiency. Finally, the "picture" can be altered by the administrator to assess the feasibility of changes, particularly the introduction of new services.

Create a "picture" of the present system

After computing weekly figures for the whole system, a yearly summary (which may be a prediction, or may be compiled from past activities) can be made. Such a summary is illustrated in Figure Twenty.

Figure Twenty

	Evaluation	Training A	Placement	Total
Referrals	520	52	26	598
Served	390	224	222	468
Self-terminate	39	68	0	107
No benefits	92	68	7	167
Placements	23	105	145	145

An illustration of a summary chart of clients flowing through a facility. The chart and data will provide valuable information to systems analysts.

The annual figures above were determined by multiplying the weekly figures by 52. From these annual figures it is possible to predict program evaluation results. For instance, 105 persons would be placed in jobs from the training program. This was estimated by multiplying 3.1 clients per week who leave the training program by 65 percent, which is the placement rate, times 52. Because 105 people are placed out of the 228 persons served, a success rate of forty-six percent is determined for this program. In the placement program, 145 placements are made from a pool of 222 persons entering the program resulting in a success rate of sixty-five percent.

Predict the effect of or need for changes

Once a real or proposed rehabilitation program has had flow analysis performed, it can be used to predict the effect of changes in the system. For example, an analyst may observe that changes in referrals will cause the dropout rate in vocational evaluation to increase from ten percent to forty percent. By changing that figure and redoing the significant calculations, the analyst may find that the annual number of placements will drop from 146 to 94. Additionally, the change in referral rate will affect the number of persons in work adjustment at any one time, dropping from 67.32 to 49.77. While, this type of prediction does not solve referral problems, it does help administrators prepare for a problem's effects. Also, a little manipulation of figures shows that if the dropout rate is increased to forty percent in evaluation, the numbers in work adjustment and placement can be maintained - if the referrals to evaluation can be increased from ten to fifteen per week. However, this will also mean that the average number of clients in vocational evaluation will increase from 28.5 to 36. Other options are available, such as increasing the number of referrals directly into the training program, which will help the program return to its needed load level.

Balance system units

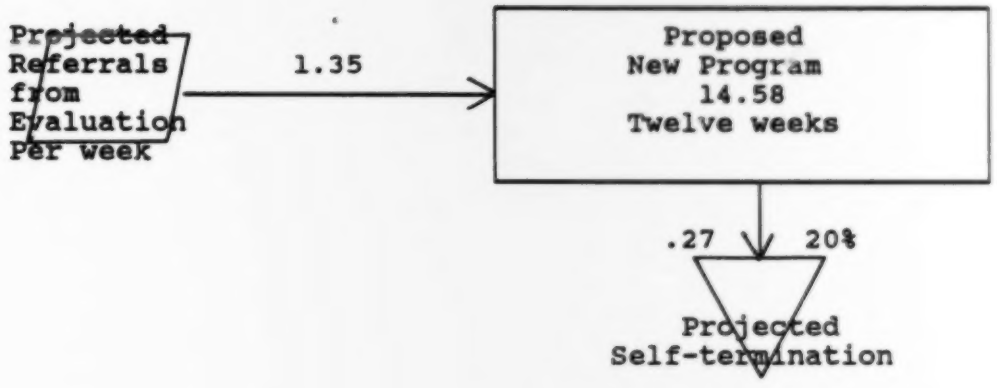
Possibly the most important use of flow analysis is to balance an existing program. For instance, if the capacity of the training program modeled above is 100, then this program is only operating at sixty-seven percent utilization. By a simple manipulation of the figures it becomes apparent that there will have to be 6.5 clients per week entering the training program in order to achieve the full load of 100 clients. If only one client per week continues to be referred directly to the training program, 5.5 clients per week must be referred from the evaluation program. An average of 16.2 referrals per week must, therefore, be made to the evaluation program to balance the system. If it is not feasible to increase referrals by six clients per week, perhaps the administrator should decrease

capacity for the training program, allocating staff and space resources to other programs. Systems analysis may be used for all rehabilitation programs. The effects of changes in client flow for any one program tends to affect all programs in the system.

Determine the feasibility of new services

Systems analysis can be used to determine the feasibility of initiating new programs. For example, if a significant number of clients are being routed to other services, the facility administrator may wish to determine the feasibility of starting an "in facility" program to address those needs. In the example above, a total of 2.7 clients (1.02 "no service" plus 1.68 "other") fall in that category. If fifty percent of this group have a common need then there is the potential of 1.35 clients per week that could enter the new program. If the new training program lasts 12 weeks, needing twenty-five clients to be cost effective, the program will never achieve a steady state equal to the cost of maintaining the program. See Figure Twenty-one below:

Figure Twenty-one



An illustration of a projected program model.

Projections for proposed programs are performed exactly as for existing programs; estimated data is used when actual data is lacking. For example, when 1.35 (the projected intake figure) is multiplied by .2 (the projected dropout rate), the resulting figure .27 is an estimate of the

average weekly number of dropouts. Subtracting .27 (the estimated dropout figure) from 1.35 (the projected intake figure) we establish a projection of the number of clients that will complete the program each week. Because the dropouts are expected to occur half way through the 12 week program, multiplying 1.35 by 6 results in an average first six week load of 8.1 and multiplying 1.08 by 6 results in an average second six week load of 6.48. Adding the figures results in a projected maximum load of 14.58 clients.

For the proposed program to be cost effective, the administrator would need to solicit referrals from other sources and/or increase the number of clients referred from the evaluation program. The administrator must also consider the effect that any change in referral pattern may have on the facilities other programs.

CHAPTER SEVEN
INTEGRATING SYSTEMS ANALYSIS WITH PROGRAM EVALUATION

Program evaluation, as defined by the Commission on Accreditation of Rehabilitation Facilities (CARF, 1985) is a systematic procedure for determining the effectiveness and efficiency with which results following rehabilitation services are achieved by persons served. System data are collected regularly or continuously and used to assess the facility's effectiveness and efficiency at providing rehabilitative services. The use of systems analysis will keep the administrator appraised of the facility's status regarding the completion of its mission. In addition, systems analysis will provide the data needed to identify and change client flow problems, resulting in better client service.

Program evaluation is also a tool for providing better services. In a program evaluation, administrators, accreditation agencies, and funding bodies examine the facility's ability to deliver the services they were organized to provide. By regularly examining facility programs using systems analysis, data is produced that is of great value to program evaluation. Essentially, systems analysis is an integral part of program evaluation.

The essential elements of program evaluation, according to CARF (1975), are:

(1) A purpose statement.
(2) A structuring of programs.
(3) A system review mechanism.
(4) Management reports.
(5) Goal statements for each program.
(6) Admission criteria for each program.
(7) A listing of services for each program.
(8) A listing of persons served for each program.
(9) Measurable objectives for each program.
(10) Measurement criteria for each objective.

(11) Specification of who is measured for each objective.
(12) Specification of the time each measure is applied for each objective.
(13) Specification of variables for each person served, including severity and barriers.
(14) Specification of success criteria for each objective.
(15) Specification of relative importance of each objective.

Note that the major elements of program evaluation include an element requiring system review (element number 3). In addition, many of the elements (underlined) call for the creation of data also collected for systems analysis. Thus, systems analysis supports the activities of program evaluation.

By creating systems analysis procedures to provide data to the facility's program evaluation system, administrators can effectively cut their planning and accounting time.

APPENDIX A
SYSTEMS ANALYSIS RESOURCES

A large number of books on the subject of systems analysis were written in the past ten years as interest in the examination of systems as a management tool expanded. This list of resources was culled from over two hundred citations at the University of Wisconsin-Stout. It provides many fine examples of texts on systems analysis. Your local public library may have several of these texts; it will certainly have others.

Awad, Elias M. (1979). System analysis and design. Homewood, IL: R. D. Irwin.

Bingham, John E. (1978). A handbook of systems analysis. New York, NY: Wiley.

Cornell, Alexander H. (1980). The decision-maker's handbook. Englewood Cliffs, NJ: Prentice-Hall.

Carlsen, Robert D. (1979). The systems analysis workbook: a complete guide. Englewood Cliffs, NJ: Prentice-Hall.

Chorafas, Dimitris N. (1965). Systems and simulation. New York, NY: Academic Press.

Davis, William S. (1983). Systems analysis and design: a structured approach. Reading, MA: Addison-Wesley.

Deutsch, Ralph. (1969). System analysis techniques. Englewood Cliffs, NJ: Prentice-Hall.

Edwards, Perry. (1985). Systems analysis, design, and development with structured concepts. New York, NY: Holt, Reinhart and Winston.

FitzGerald, Jerry. (1981). Fundamentals of systems analysis. New York, NY: Wiley.

FitzGerald, John M. (1973). Fundamentals of systems analysis. New York, NY: Wiley.

Gane, Chris. (1977). Structured systems analysis: Tools and techniques. New York, NY: Improved Systems Technologies.

Gilmour, Robert W. (1979). Business systems handbook: Analysis, design, and documentation. Englewood Cliffs, New Jersey: Prentice-Hall.

Gordon, Geoffrey. (1978). System simulation. Englewood Cliffs, NJ: Prentice-Hall.

Hare, Van Court. (1967). Systems analysis: A diagnostic approach. New York, NY: Harcourt, Brace and World.

Hilton, Everett Preston. (1970). A systems approach--1970: Vocational education handbook for state plan development and preparation. Frankfort, KY: Bureau of Vocational Education.

Huggins, William H. (1968). Introductory systems and design. Waltham, MA: Blaisdale Publishing Company.

Johnson, Richard Arvid. (1973). The theory and management of systems. New York, NY: McGraw-Hill.

Karnopp, Dean. (1975). System dynamics: A unified approach. New York, NY: Wiley.

Marshall, George R. (1985). Systems analysis and design: Alternative structured approaches. Reston, VA: Reston Publishing Company.

Matthies, Leslie H. (1976). The management system: Systems are for people. New York, NY: Wiley.

Neuschel, Richard F. (1976). Management systems for profit and growth. New York, NY: McGraw-Hill.

Ogata, Katsuhiko. (1978). System dynamics. Englewood Cliffs, NJ: Prentice-Hall.

O'Neill, William D. (1977). Systems analysis: Theory and applications. Prospect Heights, IL: Waveland Press.

Optner, Stanford L. (1973). Systems analysis: Selected readings. Baltimore, MD: Penguin.

Optner, Stanford L. (1975). Systems analysis for business management. Englewood Cliffs, NJ: Prentice-Hall.

Palm, William J. (1983). Modeling, analysis, and control of dynamic systems. New York, NY: Wiley.

Pegels, C. Carl. (1976). Systems analysis for production operations. New York, NY: Gordon and Breach Science Publishers.

Pemberton, LeRoy A. (1968). Administrative systems management. Belmont, CA: Wadsworth Publishing Co.

Ramalingam, P. (1976). Systems analysis for managerial decisions: a computer approach. New York, NY: Wiley.

Rudwick, Bernard H. (1969). Systems analysis for effective planning: Principles and cases. New York, NY: Wiley.

Robertshaw, Joseph E. (1978). Problem solving, a systems approach. New York, NY: Petrocelli Books.

Semprevivo, Philip C. (1982). Systems analysis: Definition, process, and design. Chicago, IL: Science Research Associates.

Silver, Gerald A. (1976). Introduction to systems analysis. Englewood Cliffs, NJ: Prentice-Hall.

Silvern, Leonard Charles. (1972). Systems engineering applied to training. Houston, TX: Gulf Publishing Company.

Sutherland, John W. (1977). Managing social service systems. New York, NY: Petrocelli Books.

Thierauf, Robert J. (1975). Systems analysis and design of real-time management information. Englewood Cliffs, NJ: Prentice-Hall.

Tricker, Robert Ian. (1976). Management information and control systems. New York, NY: Wiley.

White, Harry James. (1969). Systems analysis. Philadelphia, PA: Saunders.

Whitehouse, Gary E. (1973). Systems analysis and design using network techniques. Englewood Cliffs, NJ: Prentice-Hall.

Youssef, Leon A. (1975). Systems analysis and design. Reston, VA: Reston Publishing Company.